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THE STRUCTURE OF MOTIVATION FOR MECHANICAL ENGINEERING STUDY AT UNIVERSITY OF ZAGREB

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Abstract

The paper aims to explore freshmens' reasons to study mechanical engineering at University of Zagreb. These reasons are framed mostly in terms of intrinsic and extrinsic motivation. In addition, the paper examines elements of motivational structure with respect to the selected independent variables of the sample. The obtained results indicate relative significance of some independent variables and slightly more pronounced importance of intrinsic motivation.

Keywords:

Students of mechanical engineering, extrinsic motivation, intrinsic motivation, motivational structure

1. Introduction

Through the last couple of decades, students' interest in engineering study has closely corresponded to fluctuations in socio-economic development of late industrial societies. Up to 2000., this interest was decreasing due mostly to the factors of deindustrialisation and to the rising precarious character of employment with the corresponding uncertainty in terms of individual professional career and individual biography [1]. With the beginning of economic crisis in developed world in 2000s and clearly expressed orientation toward reindustrialisation interest in engineering had start to rise again. However, it unevenly affected different strains in STEM field and corresponding accademic programs [1].

Also, as related research indicates [2], number of long-standing factors inherent to academic engineering curriculum were identified as discouraging with regard to students' interest in engineering study. Predominantly narrow disciplinary focus, excessive abstraction of the studies and difficulties in understanding engineering as a social enterprise are singled out as main potential barriers to attracting the best and the most creative freshmen [3]. However, as Matusovich at al. [4] pointed out, general understanding on students' motivation to enter engineering study was still relatively poor. In other words, just mentioned socio-economic and curriculum factors needed to be upgraded by research of the structure of motivation of future engineering students.

Accordingly, the main objectives of our research are aimed to explore freshmens' reasons to study mechanical engineering at University of Zagreb in terms of intrinsic and extrinsic motivation.

As a matter of empirical and theoretical concern which is thoroughly established in psychology, research on motivation is also frequently used in the field of engineering education, although sometimes with poor conceptual background [5]. While concentrating on structure of students' motivation for engineering study, most of these studies tried to explore students' inclination toward engineering in terms of quasi-conceptual opposition between extrinsic (security, salary or social position) and intrinsic (interest in engineering or work autonomy) motivation. Extrinsic motivation reffered to someone's activity oriented toward different utilitarian aims of relativelly wide spectre - from ascribed importance to utility itself. On the contrary, intrinsic motivation reffered to activity independent on external influence, and which stemmed from interest for activity itself and was related to corresponding enjoyment [6]. However, both types of motivation have been integrated into more sophisticated models raised in expectancy theory, theory of task's importance, and theories in which motivation is associated with cognition and volition [7].

In our research we have partly relied on theoretical approach of Deci et al [6] since they indicated a need to differ between several levels along the continuum of extrinsic motivation including not only it's "pure" type (external regulation), or couple of transitional types (introjected and identified regulation), but also its the most developed type (integrated regulation) where externally regulated activities by their character were integrated into "individuals' coherent sense of self" [6]. Although this last type brings closer to intrinsic motivation, it is identified in terms of extrinsic motivation because the specific interest in an activity is not fully internally induced [6]. This conceptualisation confirms analytical usefulness of so called transitional types which on the scale of extrinsic motivation gradually get closer to intrinsic motivation. On the contrary, possibilities to operationalize intrinsic motivation are reduced to its ideal-type extreme.

2. Sample and Method

The research participants were the first year students of the Faculty of Mechanical Engineering at the University of Zagreb. During the first week of class in autumn 2014, 227 freshmen filled our questionnaire. In proportion with the number of students enrolled (435), the questionnaire comprised students of all majors. In this respect, the sample can be considered as representative.

In this paper we used descriptive and inferential statistical methods.

The descriptive statistical methods were used for describing the sample and the independent variables Besides that, inferential statistical methods were used in accordance with the goal of the research. Series of t-tests and One-way ANOVAs were made.

Independent variables consisted of 186 male students (82%) and 40 female students (18%). With regard to high school, there were 185 gymnasium students (82%) and 40 students who came from technical school (18%). 51 students estimated their family income as above average (28%), while 64 students estimated family income as average (33,%), and finally 74 students estima- ted family income as bellow average (39%). With regard to parents' education, 89 (41%) students have mothers with high school education contrary to 126 students whose mothers had college degree (59%). Finally, 97 students had fathers with high school (45%), while 118 (55%) students had fathers with college degree.

3. Results

The first variable which represents the extrinsic motivation to study engineering is an aggregate of the next categories: 1) The desirability of high salary (represented with two indicators in the questionnaire: "I joined this study primarily due to possibility to find a well-paid job" and "Above-average salary is the main factor for my choice of this study"); 2) Orientation towards work and career (represented with two indicators: "I started this study primarily due to the possibility of quick employment" and "I started this course primarily due to the possibility of fast career advancement");
2) The importance of the professional reputation in society (one indicator: "I find this study attractive mostly because of the engineers' professional reputation in society"). Questions asked are sorted by similarity into three meaningful categories. All the questions were presented 1-5 Likert scale where 1 means "Strongly disagree" and 5 "Strongly agree".

The variable which points to levels of intrinsic motivation consists of answers to the following questions: "I started this study because I am primarily interested in the field of science and technology", "I have started this study mostly by being attracted by gaining new technical knowledge", "I have already shown a preference in repairing different devices" "I enjoy solving mathematical problems", "Engineering is the official name for the hobbies I enjoy," "I prefer to deal with things rather than people." Responses were noted in the same manner as in elements of extrinsic motivation. Because of the greater variety of indicators than in the previous case we did not extract them into the common categories.

Table 1 shows that among individual extrinsic motives the possibility of fast career advancement and the possibility of quick employment dominate. Category "Job and Carrer" in which they are summed up consequently shows the highest value. They are followed by a well-paid job and professional reputation in society. The table also shows that individual variables are summed up in corresponding category including their hierarchy. The most important element of extrinsic motivation for our respondents is job and career. Professional reputation is estimated as the next in importance, while potential financial benefits (salary and well paid job) rank last. As it can be seen overall score on a scale of extrinsic motivation is 3.41.

Table 1. Elements of extrinsic motivation.

Individual variable	Mean	SD	Category	Means by category	Overall Mean	SD
Opportunity to get a job quickly	3,53	1,0	Job and career	3,57	3,41	0,80
Possibility to have fast career	3,60	1,01				
Possibility to get well paid job	3,44	1,08	Salary	3,26		
Possibility to have sallary above average	3,08	1,11				
Engineers' reputation in society	3,38	1,14	Reputation	3,38		

When it comes to the issues of intrinsic motivation (Table 2), it is evident that students put the highest scores to issues which indicate the importance of the interest in science and technology and of gaining new technical knowledge. Hierarchically, inclination towards solving mathematical problems follows immediately behind them. Finally, all of them are followed by tendency to repair various devices and the latest two are engineering as a hobby and preference to deal with things rather than people.

Table 2. Elements of intrinsic motivation.

Individual variable	Mean	SD	Overall mean	SD
Primarilly interest in science and technology	4,46	0,67	3,72	0,56
Attracted by new technical knowledge	4,09	0,8		
Inclination to fix devices has always existed	3,56	1,06		
Engineering as career name for own hobbies	3,23	0,97		
Rather being involved in things than in people	3,22	1,14		
Enjoying in solving mathematical problems	3,75	1,05		

It is easy to notice that the total score on the scale of intrinsic motivation (M = 3.72, SD = 0.55) is higher than in the case of extrinsic (M = 3.41, SD = 0.80) and testing of their differences (paired samples) showed a significantly higher intrinsic than extrinsic motivation (t = -4502, df = 226, p = 0.000).

In a few words, students are remarkably more intrinsically than extrinsically motivated. In the first type of motivation interest in science and technology, new technical knowledge, enjoying math and experience in repairing devices dominates while in the second (extrinsic) quick employment, fast career advancement, good salary and professional reputation in society prevail.

We also tested differences in the components of the both types of motivation with regard to independent variables. Independent variables used are: Sex (M/F), High school (technical or gymnasium), monthly income per capita (below average, average or above average), mothers' education (high school or college) and fathers' education (high school or college).

When it comes to extrinsic motivation, it's each component is observed particularly with regard to social groups represented in the independent variables. Table 3 indicates that overall extrinsic motivation rises as the parents' educational level is smaller. In both cases - mother's and father's education - significanrt difference was found. Also, as it is visible in Table 3, father's education is expressed by greater significance. With regard to other independent variables we found no significant differences.

Table 3. Differences in levels of overall extrinsic motivation (EM) with regard to independent variables.

		N	EM Overall Mean	SD	EM Overall Difference sig.
Sex	Male	186	3,35	0,82	n.d.
	Female	40	3,59	0,69	
High school	Gyumasium	185	3,38	0,77	n.d.
	Technical high school	40	3,55	0,93	
Income	Bellow avegage	74	3,50	0,76	n.d.
	Average	64	3,38	0,80	
	Above average	51	3,41	0,86	
Mothers' education	High school	89	3,54	0,79	0,017
	College	126	3,30	0,79	
Fathers' education	High school	97	3,57	0,66	0,003
	College	118	3,25	0,87	

Detailed analysis of specific extrinsic motivation components (Table 4) shows that the element of job and career in extrinsic motivation is more important to female than to male students. Similarly, students who came from technical high schools found professional reputation of engineers more important than the students who came from gymnasium. Among income groups there is no difference in any of the components. On the other side, students with less (high school) educated mothers consider job, career and salary more important than students whose mothers have college diploma. Finally, students with less educated fathers gave more importance to all three components of extrinsic motivation (Job and Career, Salary, Professional reputation) than those students whose fathers have college degree. Finally, It is noticable that salary as the component of extrinsic motivation showed no differences across all independent variables except parents' education. In discussion we shall concentrate on elements which proved to be consistent in both, the overall and the detailed differences in extrinsic motivation.

With regard to the issue of intrinsic motivation the same procedure as in the previous case was repeated. However, because of the variables' diversity they were more difficult to be summed up in a category of higher order so that was not done. Table 5 shows that there are no significant differences in terms of any single independent variables when considering the overall intrinsic motivation. More precisely, it can be said that the difference in overall intrinsic motivation between the sexes doesn't exists. Likewise, there is no difference regarding the high school, family income or level of parental education.

Table 4. Differences in components of extrinsic motivation (EM) with regard to independent variables

		N	Job and career	Job and career sig.	Salary	Salary sig.	Professional Reputation	Professional Reputation sig.
Sex	Male	186	3,51	0,046	3,23	n.d.	3,33	n.d.
	Female	40	3,81		3,38		3,58	
High School	Gymnasium	185	3,58	n.d.	3,24	n.d	3,31	0,048
	Technical school	40	3,58		3,38		3,70	
Income	Bellow average	74	3,60	n.d	3,43	n.d	3,46	n.d.
	Average	64	3,46		3,24		3,42	
	Above average	51	3,67		3,21		3,35	
Mothers' education	High school	89	3,70	0,048	3,42	0,034	3,51	n.d.
	College	126	3,46		3,13		3,29	
Fathers' education	High school	97	3,71	0,02	3,45	0,004	3,55	0,049
	College	118	3,43		3,06		3,25	

Table 5. Differences in levels of overall intrinsic motivation (IM) with regard to independent variables

		N	IM Overall Mean	SD	IMO Difference sig.
Sex	Male	186	3,71	0,53	n.d.
	Female	40	3,79	0,64	
High school	Gyumasium	185	3,72	0,56	n.d.
	Technical high school	40	3,74	0,55	
Income	Bellow avegage	74	3,77	0,49	n.d.
	Average	64	3,72	0,56	
	Above average	51	3,73	0,61	
Mothers' education	High school	89	3,68	0,59	n.d.
	College	126	3,62	0,53	
Fathers' education	High school	97	3,65	0,55	n.d.
	College	118	3,74	0,55	

Detailed analysis of specific intrinsic motivation components (Table 6) shows that the students with more educated fathers show more interest in science and technology than students with less educated fathers. In three variables: “Gaining new technical knowledge", "Experience in repairing devices" and "Dealing with things rather than people” there is no differences between groups of independent variables. Students with below-average family income (M=3,96, SD=0,867) enjoy in mathematics more than students with above-average family income (M=3,47, SD=1,255), and it was confirmed by One-way ANOVA F(2, 188) = 3,372, p=0,027. Students with more educated mothers prefer engineering as a hobby more than those who have less (high school) educated mothers. Also, contrary to common perception on gendered nature of differences with regard to inclination toward natural sciences' school subjects such as math, physics etc., we found that female students enjoy in solving mathematical tasks and problems much more than their male colleagues.

4. Discussion

Considering the main objectives of this enrolled the study of mechanical engineering and naval architecture at University of Zagreb in 2014, was primarily intrinsically motivated. This finding is confirmed by testing the differences between overall means in extrinsic and intrinsic motivation and it indicates statistically significant higher value of intrinsic motivation indicators.

To some extent, this finding corresponds to results found in similar studies conducted in Croatia. It is consistent with findings in research done by Kesić and Previšić [8] who compared the motives for enrolling into faculties of economics and electrical engineering. Although their two-factor motivational structure corresponded to a simplified matrix of extrinsic and intrinsic motivation, their findings indicated primary importance of intrinsic motives not only in process of study-enrolment decision making, but also in students' images on their own future profession. Also, our finding is relatively consistent with those in Potočnik's research [9]. Despite some differences in sample, methodology and overall results (she researched the students' motives for enrolling at the University of Zagreb and she combined qualitative and quantitative approach), it was determined that the majority of students, including those studying technical sciences, have a prevailing interest in the studies, while independent variables such as gender, age and years of study do not represent relevant factors.

Table 6. Differences in components of intrinsic motivation (IM) with regard to independent variables

		Interest in S&T	Interest in S&T sig.	New technical knowledge	New technical knowledge sig.	Inclination to fix devices	Inclination to fix devices sig.
Sex	Male	4,43	n.d.	4,11	n.d.	3,58	n.d.
	Female	4,60		4,03		3,50	
High School	Gymnasium	4,49	n.d.	4,09	n.d.	3,53	n.d.
	Technical school	4,43		4,10		3,70	
Income	Bellow average	4,47	n.d.	4,11	n.d.	3,74	n.d.
	Average	4,47		4,20		3,44	
	Above average	4,57		4,20		3,43	
Mothers' education	High school	4,39	n.d.	4,13	n.d.	3,63	n.d.
	College	4,50		4,06		3,49	
Fathers' education	High school	4,31	0,005	4,14	n.d.	3,53	n.d.
	College	4,57		4,02		3,57	
		Enjoy in math	Enjoy in math sig.	Things before people	Things before people sig.	Engineering as hobby	Engineering as hobby sig.
Sex	Male	3,65	0,003	3,18	n.d.	3,29	n.d.
	Female	4,20		3,45		2,98	
High School	Gymnasium	3,77	n.d.	3,23	n.d.	3,21	n.d.
	Technical school	3,65		3,20		3,35	
Income	Bellow average	3,96	0,036	3,11	n.d.	3,23	n.d.
	Average	3,77		3,17		3,27	
	Above average	3,47		3,37		3,33	
Mothers' education	High school	3,82	n.d.	3,09	n.d.	3,07	0,041
	College	3,68		3,29		3,34	
Fathers' education	High school	3,73	n.d.	3,08	n.d.	3,12	n.d.
	College	3,73		3,30		3,28	

However, it is necessary to clearly point out that finding on importance of intrinsic motivation should not neglect the importance of extrinsic motivation since some other research emphasized the concurrent importance of extrinsic and intrinsic motivation [10]. Also, our finding should be related to contextual factors of engineering study itself [11]. as well as to the fact that choice of study is of highly contingent character [12].

The structure of each type of motivation (including their particular components) with regard to independent variables allows for discussion of the most consistent results. Level of parents' education - including mothers and fathers - proved to be significant factor with regard to overall extrinsic motivation and with regard with to almost all of its components. Our findings indicate that in both cases students whose parents have high school degree are significantly more extrinsically motivated to enroll engineering study. In other words, it seems that students with less educated parents strive more for good salary, quick employment and career advancement. To some extent, this finding corresponds to approaches in which education is confirmed as potential factor in social mobility, although educational system is also proved to be important vehicle in context of social class reproduction.

At the level of overall intrinsic motivation we found no significant differences with regard to independent variables. However, analysis of particular components of intrinsic motivation indicates couple of significant differences. The most striking is one that stays contrary to the conventional and traditional values on gendered nature of inclinations toward natural and technical sciences. We found that female students enjoy in math more than male students and this finding is indicated as the most significant among all other differences found in context of intrinsic motivation. In corresponding research Jugović [13] indicated that there were no differences between boys and girls when it comes to personal importance and the assessment of their own abilities in the area of science. Although she concentrated on gender differences in the field of physics her findings are of reference for our research results.

5. Conclusion

Our findings are consistent with corresponding research on students' motivation to enroll different - including engineering - academic study programs in Croatia. Although intrinsic motivation is proved to be significantly more important in choosing to enroll engineering study, analytical usefulness of concept of extrinsic motivation in terms of continuum indicated primarily students' need to achieve their professional choice through education. Differences in components of extrinsic and intrinsic

motivation are singled out in some details which have to be verified in next researches.

Finally, all results should be considered with regard to the fact that they represent one generation of freshmen at single engineering faculty in Zagreb.

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